PART 1

Industries of the Future Strategy

A Powerful Partnership

Industry consumes about 38% of all energy used in the United States. By adopting more energy-efficient technologies, U.S. industry can boost its productivity and competitiveness while simultaneously strengthening national energy security, improving the environment, and reducing emissions implicated in global climate change.

The Office of Industrial Technologies (OIT) works in partnership with U.S. industrial firms to increase the efficiency with which industry uses energy and materials both now and in the future. Through an innovative, industry-driven strategy known as Industries of the Future (IOF), OIT helps industry develop and apply advanced, energy-efficient technologies. The strategy optimizes the energy and environmental benefits of OIT's technology investments by focusing on nine energy-intensive industries and by fostering the formation of collaborative public-private partnerships.

AN INDUSTRY-DRIVEN APPROACH

OIT's Industries of the Future strategy is designed to help U.S. industry increase its energy efficiency and boost productivity, thereby reducing waste and emissions and paving the way for market growth. Most significantly, the strategy enables industry to take the lead in defining its own technology needs. Industry identifies and establishes its technology priorities, providing authoritative guidance for focusing public and private resources on industry's toughest technical challenges. Using this approach, OIT is effectively leveraging scarce federal research and development (R&D) dollars to achieve its twin missions of improving industrial energy efficiency and reducing environmental impacts of industrial processes.

FOCUS ON ENERGY-INTENSIVE INDUSTRIES

Many of the most energy-intensive industries in the U.S. economy are involved in the initial processing of raw materials. These industries necessarily use tremendous amounts of heat and energy to physically or chemically alter the materials and prepare them for further processing or use in manufacturing. OIT maintains cooperative partnerships with nine industries, which, as a group, account for 67% of all energy used by U.S. industry and roughly 25% of all U.S. energy use:

- agriculture (renewable, bio-based products)
- aluminum
- chemicals
- forest products
- glass
- metalcasting
- mining
- petroleum
- steel

Since most of the products of these industries do not go directly to the consumer market, the average consumer tends to overlook the importance of these industries. In essence, however, these nine industries are the foundation of the U.S. economy. They produce more than 90% of the materials used in our finished products, manufacturing equipment, buildings, transportation vehicles, and infrastructure. They also produce $1 trillion in annual shipments and account for 5% of the GDP. They directly provide more than 3 million well-paying jobs and generate four times as many additional jobs in related industries. Not surprisingly, these same industries are among the largest producers of waste, representing a significant opportunity for energy savings and improved environmental performance.

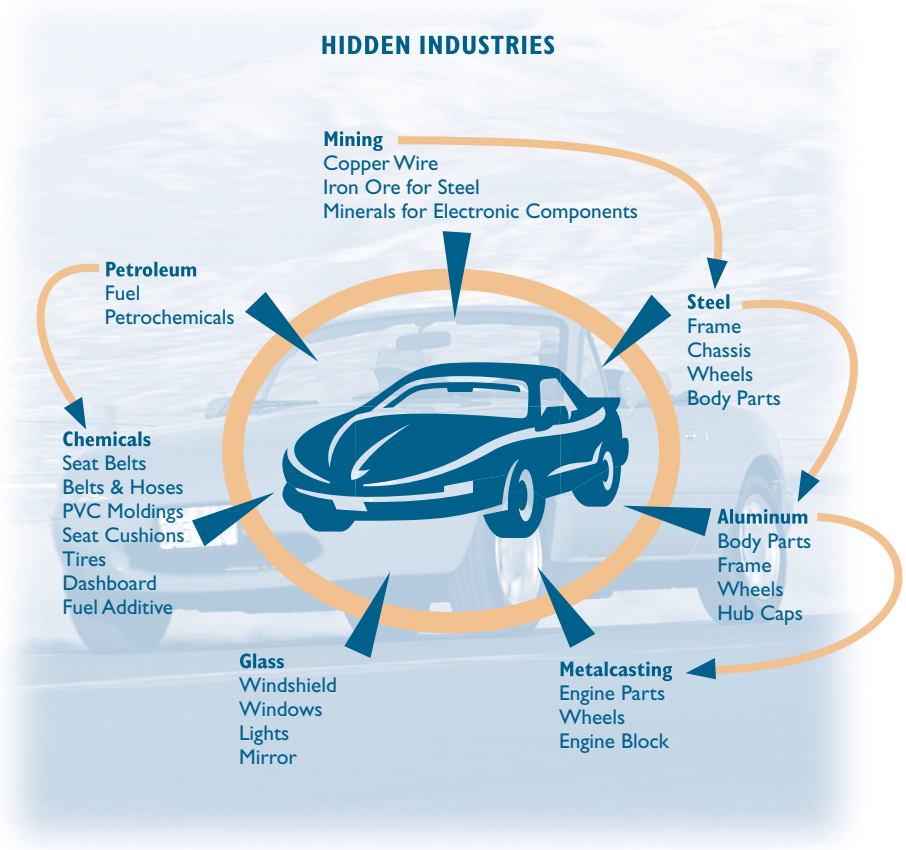
CHALLENGES

OIT's partner industries face tough economic, technological, and environmental challenges in an increasingly global marketplace. Survival in this market depends upon distinguishing one's product from those of competitors or offering the lowest price. U.S. manufacturers frequently find themselves in direct price competition with foreign firms that employ cheap labor, receive special support from their governments, or are subject to less stringent environmental regulation.

U.S. manufacturers must comply with strict environmental guidelines, offer good wages, and provide safe working conditions. To succeed in open markets while adhering to and improving on these standards, U.S. industrial firms require advanced technologies, processes, and practices that can further increase productivity, reduce unit costs, and enhance product quality while minimizing waste and emissions. Such advances support U.S. economic growth and address the risk of global climate change.

Today's industries are in a bind: at the same time they must cut costs to stay competitive (particularly the basic materials industries), they must also invest in basic and applied R&D to develop the technologies that will boost productivity, improve product quality, and address environmental challenges.

Recent technological developments present both hurdles and opportunities for major advances in industrial technologies and processes. As manufacturing processes have grown more sophisticated and products more complex, R&D increasingly requires a broad range of specialized facilities and disciplines, dramatically increasing costs. At the same time, the explosive growth in information technology has raised the feasibility of truly integrated manufacturing and real-time process control, which could significantly increase productivity.



DRIVING THE NEED FOR BASIC & APPLIED R&D

Market Globalization

As national trade barriers continue to fall, the purchase of undistinguished commodities (such as steel or aluminum sheet) on the open market will be based increasingly on price alone. Basic processing industries need to distinguish their products in terms of quality or beat the price of all competitors.

Climate Change

As the nation's largest energy-consuming sector, industry will be called upon to help reduce emissions of greenhouse gases. Progressive companies are investing in technologies to reduce emissions as the responsible course of action. Others are restricting emissions as a wise business strategy, anticipating that such restrictions will soon be required.

BARRIERS TO BASIC & APPLIED R&D

Pressure for Near-Term Profits

Manufacturers are under pressure to show near-term profits. Basic materials industries already operate on extremely narrow margins, and many firms have essentially no R&D budget. Any investment in product development necessarily detracts from basic research activities—the type of research that could lead to major technology breakthroughs and open new markets.

R&D Trends

While R&D investment is robust, more than 93% of industry's R&D spending goes to applied research and product development.

Escalating R&D Costs

The increased technological complexity of materials, processes, and products requires expertise in an expanding range of disciplines. The scientific, technological, and business resources for needed research have grown beyond the reach of many individual manufacturers.

The Evolving "Industries of the Future" Process

OIT's innovative Industries of the Future strategy helps entire industries to define their long-term goals, identify their most critical needs for the future, and enter into public-private partnerships to share the costs and risks of R&D and technology advancement. The approach takes full advantage of the unique insight and resources that industry itself can bring to the R&D planning and implementation process. By giving industry "ownership" of the process, the strategy obtains strong industry commitment to the R&D and essentially ensures widespread adoption of the resulting energy-efficient technologies.

Since 1994, OIT has been using this highly successful strategy to identify the energy-related technologies most needed by some of our nation's most energy-intensive industries. The Industries of the Future model is simple and flexible. OIT facilitates the process, but the industries themselves take the lead to

- set their own industrywide goals for 2020 and beyond
- develop detailed R&D agendas for achieving those goals
- form collaborative partnerships to share the costs and risks of the needed R&D.

VISIONS

OIT brings together the diverse sectors of an industry and assists them in creating a common strategic vision for the future. Leading representatives from each industry are asked to anticipate the likely economic, regulatory, and market pressures on their industry 20 years from now. On the basis of those projections, they jointly develop a unified vision of their desired future and the types of capabilities they will need to survive and prosper. The resulting vision outlines the industry's explicit market, business, and technology goals for the next 20 years.

ROADMAPS

Based on its strategic vision, each industry then develops a technology roadmap, which sets priorities, articulates specific technology strategies, and provides a comprehensive R&D agenda. Roadmaps lay out a logical, prioritized sequence of R&D for the long term. They identify discrete areas of research and provide quantified performance targets and milestones for the work. In some cases, roadmaps may also suggest appropriate roles for government and other research partners.

Knowledgeable and experienced individuals representing a broad cross-section of each industry participate in roadmap development. In addition, representatives of major suppliers, customers, and research organizations contribute valuable input to these "living" documents. The roadmaps are regularly updated by the industries to reflect new trends and developments.

OIT assists industry during the roadmapping process and acts as a neutral party to help competitors, suppliers, customers, and other key stakeholders reach a consensus. The published roadmaps effectively align public and private technology investments to solve the most critical common challenges facing industry and the nation.

Industries of the Future Process

The government is no longer a rulemaker or an adversary, but rather a facilitator and partner.

Denise Swink
DOE's Deputy Assistant Secretary
for Industrial Technologies

PARTNERSHIPS

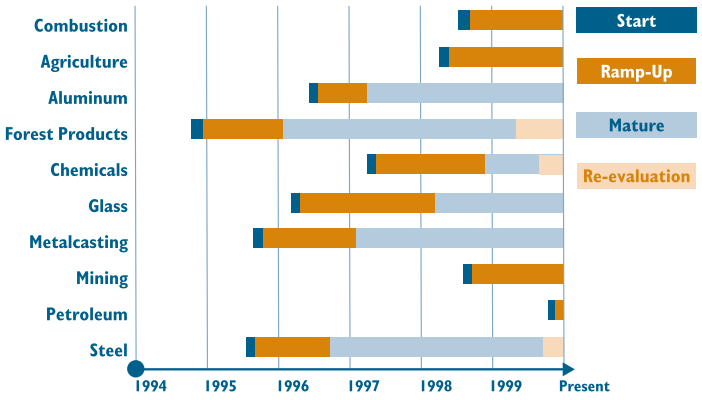
The roadmaps are used to guide the formation of collaborative technology partnerships composed of private companies, suppliers, industry associations, national laboratories, private research institutions, government agencies, and other interested organizations. These partnerships can investigate promising, complex technology options that would be too costly for individual firms to undertake. OIT facilitates the planning process, serves as a clearinghouse for potential partners, and cost-shares projects that help achieve its energy and environmental goals.

By spreading the R&D costs and risks among partners, the strategy counteracts pressures that currently tend to discourage private firms from pursuing the long-term, high-risk R&D necessary to support progress toward more efficient technologies.

Through competitive solicitations, OIT supports a broad portfolio of collaborative, cost-shared R&D projects that will yield results over the near, mid, and long term. By concentrating on high-risk, high-payoff R&D projects in pre-competitive areas, U.S. firms in these industries are finding that they can work effectively in cooperation with traditional competitors and other partners to accelerate the pace of technology development and boost the competitiveness of their entire industry. Spreading the costs and risks of R&D appeals to private firms and public agencies alike, but the benefits don't end there. The quantity, quality, efficiency, and speed of R&D are markedly increased.

OIT's Industries of the Future strategy enjoys a high level of industry support and has received numerous accolades from industry and government leaders. Additional industries, including forging, heat treating, welding, advanced ceramics, powdered metals, and industrial process heating, have recognized the far-reaching benefits of the approach and have requested OIT assistance in vision and roadmapping efforts.

INDUSTRIES OF THE FUTURE PROGRESS



Streamlined Solicitations

OIT's new R&D project awards are determined through a competitive solicitation process in which industry takes an active role. Task groups composed of industry experts help define the precompetitive technology areas to be targeted in the solicitations and later conduct technical assessments of the proposals received from prospective R&D partners. OIT makes the final selections based on each proposal's potential contributions toward energy-efficiency, productivity, and environmental goals.

For each award, OIT requires its partners to contribute between 30% and 50% of total project costs, with the partners' share normally increasing as the technology or process nears the commercialization stage. In this way, OIT stimulates the commitment of additional funds to needed R&D.

In response to feedback from customers, OIT has been streamlining its solicitation process. At its Idaho Operations Office, for example, rather than demanding a full-scale, highly detailed proposal up front, initial submissions now sometimes require only a 15-page "overview" and a one-page cost summary sheet. Similarly, pre-award audits are now conducted only on an "as-needed" basis, and the solicitation package has been simplified and shortened, with clearer language and fewer mandatory forms and certifications. These changes represent only the beginning of OIT's solicitation simplification and streamlining efforts.

PARTNERSHIP MECHANISMS

Industry can use a variety of mechanisms to participate in OIT programs. These include the following:

- *Cost-Shared Financial Assistance Awards and Cooperative Agreements*—A financial assistance award is a legal instrument reflecting a negotiated agreement between a private firm or firms and the government. It is usually cost-shared. To protect proprietary interests of private parties, the government generally agrees not to disseminate commercially valuable data that is generated under a cost-shared financial assistance award for a specified period of time.

  Cooperative agreements may also reflect a relationship between the federal government and state or local government or universities in order to support or stimulate R&D. In cooperative agreements, substantial involvement is anticipated between DOE and the recipient during the performance of the contemplated activity.

- *Cooperative Research and Development Agreements (CRADAs)*—CRADAs are agreements between government laboratories and nonfederal parties in which both participants provide personnel, services, facilities, or equipment to conduct specified R&D. The nonfederal parties may also provide funds, as no direct funding is provided by the laboratory. Rights to inventions and other intellectual property are negotiated between the laboratory and participants.

- *R&D Consortia*—Consortia are arrangements involving multiple federal and nonfederal parties working together toward a common R&D objective. Funding for R&D consortia may be shared, but usually no funds are exchanged between participants.

- *Exchange Programs*—These programs allow government or laboratory employees to work in industry facilities, and industry personnel to work in government labs and facilities. Exchange programs enhance technical capabilities and are used to support R&D in specific areas. Costs are borne by the organization sending the personnel. Intellectual property rights are set forth in the exchange agreement.

- *User Facility Agreements*—These agreements permit private parties to conduct R&D at a DOE laboratory. For proprietary R&D, the laboratory is paid for the full cost of the activity. If the work will be published, the cost can be adjusted. Intellectual property rights generally belong to the private-party user of the facility.

- *Work-for-Others (WFO) Agreements*—WFO agreements accommodate proprietary work for a nonfederal party done by technically qualified government laboratory staff using laboratory facilities, with full costs charged to the nonfederal party. Title to intellectual property generally belongs to the party sponsoring the work. The government retains a nonexclusive royalty-free license to such intellectual property.

Protection of Property Rights

Rights to intellectual property developed as a result of DOE's financial assistance and R&D partnership mechanisms vary widely. They depend on factors such as the nature of the technology, the contracting instruments, the recipient cost-share, the type of performing organization, and the source of funding. The financial assistance award is the principal mechanism used by OIT to support R&D, which almost always involves recipient cost sharing of 30% to 50%. Generally, DOE will honor requests for intellectual property rights to awardees who substantially cost-share the development of new concepts in non-nuclear or non-defense applications.

Financial assistance awards are based on the premise that it is in the public's interest for the work to be supported by DOE. Successful OIT-supported technologies help create jobs, stimulate economic growth, and improve the nation's energy efficiency. Benefits are conferred on both the producers and consumers of these technologies, as well as the government.

DOE financial assistance awards do not entitle the government to ownership of any pre-proposal know-how, nor is the knowledge contained in proposals available to the public under the Freedom of Information Act. Financial assistance awards can protect proprietary information from public disclosure for up to five years. However, data on the performance characteristics of devices or systems under development must be provided to the government. DOE has the right—indeed, the responsibility—to verify performance data of any technology supported through financial assistance awards. This measure affirms any efficiency, environmental, or other performance characteristic claimed for the technology.

Industrywide Technology Support

In addition to supporting priority R&D for specific partner industries, OIT's Industries of the Future strategy embraces efficiency improvements in technologies and processes that can be widely used by many of the IOF industries and, indeed, by a large cross-section of all U.S. industry. Technologies emerging from OIT-supported R&D in these crosscutting areas often undergo further development for application in specific industries. For the near term, OIT's BestPractices program also provides a wide range of technical assistance designed to help U.S. industry adopt and apply the cleanest and most energy-efficient technologies and practices currently available.

ENABLING TECHNOLOGIES

Cost-shared R&D in crosscutting technologies enriches the knowledge base and enables the development of revolutionary new technologies. Given the scale of use these technologies receive throughout industry, even small improvements can mean substantial energy and cost savings at the national level. OIT conducts programs to advance technology in each of the following crosscutting areas (see page 108 for further detail):

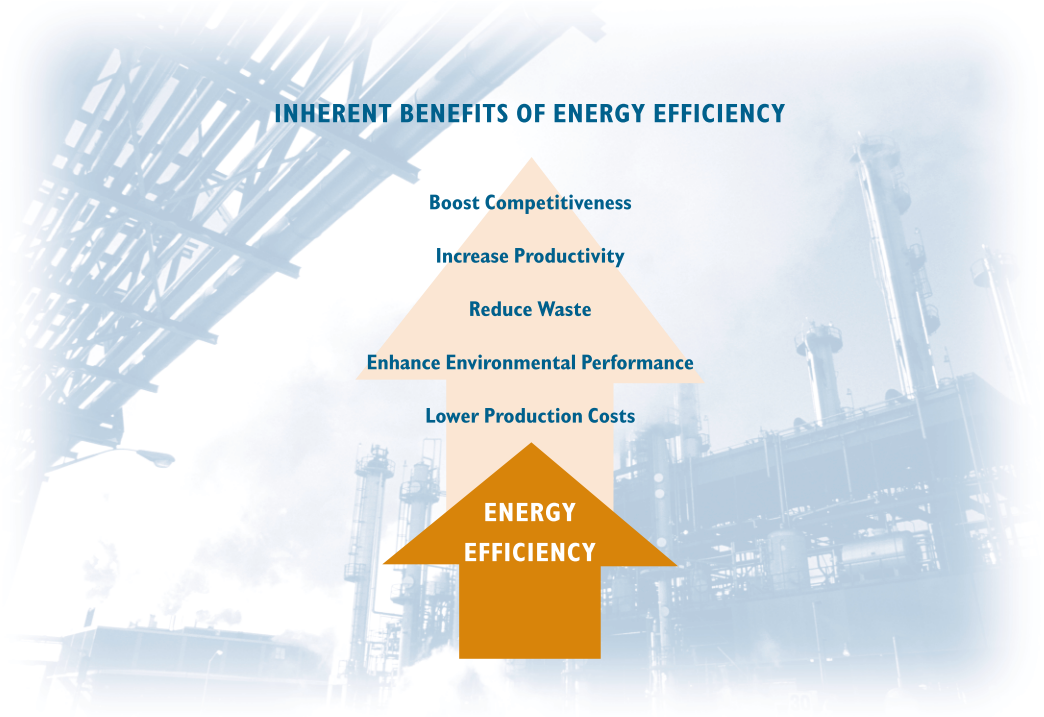
- **Combustion Systems.** Approximately two-thirds of the energy used by U.S. manufacturing is supplied by combustion systems. Cleaner, more efficient combustion equipment will improve energy efficiency and flexibility, reduce emissions, and boost productivity in a wide range of industries. Priority needs include burner development and efficiency improvements in industrial boilers and process heating systems.
- **Sensors and Controls.** Advanced sensor and control technologies will improve monitoring of process parameters, even in harsh environments, and accelerate correction measures to save time, energy, and materials. Advances in sensors and the integration of data from diverse types of sensors are needed to harness the potential of real-time control.
- **Industrial Materials of the Future.** New capabilities for designing intermetallic alloys, ceramic composites, microstructures, and specialized coatings hold solutions to many industrial processing challenges. Materials that resist high-temperature fatigue, corrosion, and wear will enhance productivity, product quality, and energy efficiency.

Benefits of these R&D efforts go well beyond OIT's energy-intensive target industries to enable improvements in productivity and energy efficiency throughout U.S. industry.

BESTPRACTICES: BOOSTING PRODUCTIVITY TODAY

The Office of Industrial Technologies offers a broad array of tools, information, and assistance that makes it easy for companies to identify and adopt more efficient practices and technologies on a plant-wide basis. Manufacturing plants can take advantage of BestPractices' plant-wide assessments and other resources to make sure all operations and practices are as efficient as they can be with today's technology. As the near-term component of OIT's Industries of the Future strategy, BestPractices helps plants start saving money right away by applying the most energy-efficient technologies and practices currently available or just emerging from R&D.

Energy efficiency is a powerful, relatively untapped business strategy for improving a company's bottom line. In addition to lowering costs, energy-efficient technologies often boost productivity, reduce or eliminate waste, create saleable by-products, aid compliance with emissions regulations, and improve product quality. OIT actively encourages the adoption of clean, efficient technologies that are available to help manufacturers begin saving energy and money right away. OIT's BestPractices program provides technical assistance emphasizing decision tools, demonstration of emerging technologies, identification of opportunities for energy savings, and heightened awareness of the benefits and correct applications of energy-efficient technologies. In all these efforts, OIT advocates a systems approach and steady, incremental improvements in efficiency.



MOTOR SYSTEMS: BOTTOM LINE IMPACTS

Industry Sector	Annual Savings per Establishment	Savings (% Operating Margin)
Paper Mills	$659,000	5
Petroleum Refining	$946,000	1
Inorganic Chemicals	$283,000	6
Paperboard Mills	$492,000	5
Steel Mills and Blast Furnaces	$358,000	2
Organic Chemicals	$91,000	1
Industrial Gases	$116,000	13
Plastics and Resins	$121,000	1
Cement, Hydraulic	$219,000	4
Pulp Mills	$483,000	5

Technical Assistance

OIT's technical assistance programs provide a variety of tools, training, and information that can help plant managers make informed decisions affecting plant efficiency. Technical experts in a variety of industrial plant systems are available to answer questions on optimal matching and integration of components within and among plant systems, including electric motors, steam, compressed air, and process heating.

Through BestPractices, manufacturing plants have access to training and tools that can help to quickly identify opportunities for efficiency improvements. Tools are available for such diverse tasks as selecting, purchasing, and deciding to repair or replace electric motors; evaluating the use of adjustable speed drives; finding potential savings in pump systems; and optimizing savings in steam pipes and equipment. Software tools, workbooks, and databases are delivered to industry through a variety of channels, including the OIT Clearinghouse, OIT Resource Center, Internet, or professional technical societies. While program participation is strictly voluntary, the potential energy and cost savings associated with the use of these tools have attracted widespread interest and involvement.

Plant-Wide Assessments

Manufacturing plants may also be eligible for a free or cost-shared energy efficiency assessment to assist in identifying the most promising savings opportunities. Small and medium-sized plants may be eligible for a free, one- or two-day assessment by one of OIT's 26 university-based Industrial Assessment Centers. Larger plants may respond to periodic OIT solicitations for more comprehensive in-plant assessments (see page 114 for further information).

FINANCIAL ASSISTANCE FOR INVENTIONS AND DEMONSTRATIONS

OIT helps U.S. industry implement energy-efficient technologies through two specialized financial assistance programs: Inventions and Innovation (I&I) and National Industrial Competitiveness Through Energy, Environment, and Economics (NICE^3). These programs target the Industries of the Future, but also address the needs of other industries (see page 118 for more detail).

The Inventions and Innovation Program evaluates the technical merits of energy-related inventions submitted by individual inventors and small businesses and provides financial and technical assistance to the most promising ideas. The program issues annual solicitations for technologies and concepts that will help achieve selected performance targets identified by OIT's partner industries.

NICE^3, a cost-sharing grant program, helps fund state-industry partnerships seeking to *demonstrate* technologies that promote energy efficiency, clean production, and economic competitiveness.

Leveraging Opportunities

Recognizing the limits of available federal funding for energy efficiency, OIT capitalizes on various opportunities to leverage its funds by networking and partnering with a range of other organizations and funding sources.

STATE-LEVEL IOF

States can play an important role in encouraging industrial innovation and adoption of energy-efficient technologies. Since energy-intensive industries are key to the economies of most states, there is a natural basis for partnership between state governments and the industries within their borders. This relationship has been widely recognized and has given rise to an extensive network of partnerships among state agencies, industry associations, and regional agencies. The IOF strategy capitalizes on these networks and seeks to expand them to leverage funding and other resources for implementing the IOF roadmaps.

OIT continues to maintain and expand the State Industries of the Future initiative by working in partnership with state energy and economic development offices, universities and land-grant colleges, laboratories and research institutions, and industry representatives and associations. OIT supports state industrial development by investing in state projects competitively awarded through the State Energy Program's Special Project State Grants.

States that participate in the IOF program gain a variety of benefits. In addition to helping state industrial programs improve their focus on industry needs, state-level participation in IOF facilitates access to OIT/DOE resources such as the Laboratory Coordinating Council (LCC), Regional Centers for Innovation, Regional Offices, and technical and financial assistance programs. Speakers from the national-level program are also made available to address state industry groups.

DOE NATIONAL LABORATORIES

DOE's National Laboratory System is a priceless resource for the development of cleaner, more energy-efficient industrial technologies. The 17 laboratories and facilities in the system represent a wealth of technical knowledge and expertise plus highly specialized equipment necessary to advanced R&D.

To support OIT and the Industries of the Future, the Laboratory Coordinating Council (LCC) gives U.S. industry access to a "virtual" laboratory that can be tailored to meet the specific requirements of almost any R&D project. Industry researchers no longer need to approach each lab separately to gauge suitability and work out agreements. The laboratories now function in a distributed manner through common intellectual property agreements and other mechanisms.

To facilitate industry access, the LCC has developed a matrix of competencies identifying the laboratories and facilities with specific areas of excellence. The matrix links each of the priority technology areas identified by the industries with laboratory areas of directly related and crosscutting R&D expertise.

EXPO

OIT sponsors the *Biennial Industrial Energy Efficiency Symposium and Expo* in partnership with some of the leading companies participating in the Industries of the Future strategy. The event attracts manufacturers, suppliers, university

A new document from the LCC explains how industry can work with the national laboratories. Download your copy from www.oit.doe.gov/LCC.

researchers, National Laboratory scientists, Congressional staffers, government officials, and others from across the country. The Expo offers a unique forum for networking, meeting potential partners, and sharing successes and new challenges. Sessions and speakers are organized to address issues, trends, and technologies that will help IOF industries and individual companies improve their efficiency and competitiveness. The popular Exhibit Hall features scores of booths highlighting revolutionary technologies now under development, cutting-edge processes emerging from research, and other exciting benefits of collaborative partnerships.

TECHNOLOGY SHOWCASES

OIT periodically sponsors industry showcases to highlight the advanced technologies, processes, and practices of interest to a particular industry. These events allow members of an industry to get a firsthand look at a variety of energy-efficient technologies emerging from OIT-sponsored R&D and the savings possible through the adoption of a systems approach to energy analysis. Participants attend briefings, plant tours, and demonstrations to learn about new processes, technologies, and practices, and see them in use at an operating plant.

Showcase formats are flexible, and OIT works closely with the host company to address any safety or security concerns. In addition to the energy and cost savings that accrue from the adoption of energy-efficient technologies and practices, past showcase hosts have noticed that other companies demonstrate an increased willingness to cooperate with them on solutions to technical concerns. Past hosts have included the following facilities:

- Bethlehem Steel's Burns Harbor Division
- Lester Precision Die Casting
- U.S. Steel's Edgar Thomson Plant
- Weirton Steel

OIT salutes these companies and future showcase hosts for their pioneering spirit and exemplary operations.

INFORMATION RESOURCES

OIT provides a wealth of technical publications, fact sheets, and other materials of interest to industry CEOs, plant managers, engineers, researchers, and others. To help our customers find exactly what they're looking for, we offer several initial points of access:

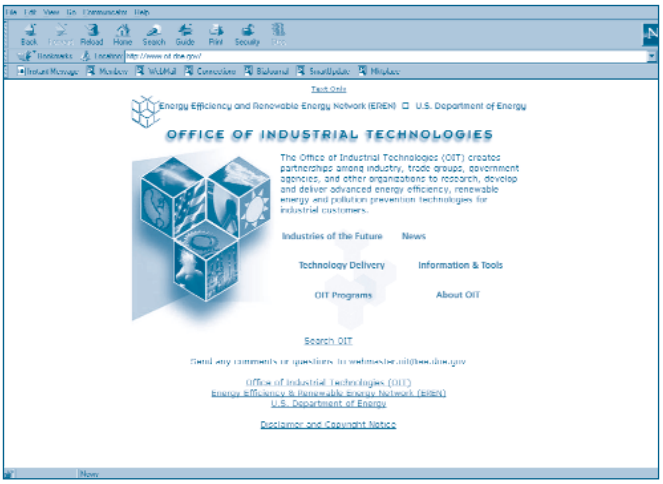
OIT Clearinghouse: Our on-call team of 17 professional engineers, scientists, research librarians, energy specialists, and communications information staff is prepared to help you find the right OIT tools, resources, or information. They can offer answers to immediate questions, suggest relevant OIT resources, send you OIT publications and products, provide technical assistance, or refer you to industry experts or DOE staff. Since 1994, the Clearinghouse has handled over 26,000 cases of programmatic and technical assistance to U.S. industry. Call 800-862-2086.

Newsletters: OIT keeps its industry partners and other customers up to date on program and partnership activities through the *OIT Times*. This quarterly newsletter has all the latest information on technology successes, new solicitations and awards, showcases, conferences, and other events of interest. The bimonthly *Energy Matters* newsletter focuses on best practices for improving industrial energy efficiency using existing technologies. Each issue highlights successes, offers tips for boosting efficiency, and provides information on tools, training, and other assistance available through OIT. To get your name on the mailing list for either or both publications, please call 800-862-2086.

OIT's Information Resources Catalog: OIT's catalog provides a comprehensive listing of available OIT videos, software, publications, and other informative resources, conveniently cross-referenced by industry and technology area. Also available online at www.oit.doe.gov/catalog.

Industry Profiles: Detailed reports describe the energy use and environmental characteristics of each of the key manufacturing processes within an industry. These profiles provide useful benchmarks for measuring the benefits of new and more efficient technologies. Energy and environmental profiles are currently available for the Chemicals, Steel, Aluminum, Petroleum, Metalcasting, and Mining industries, and additional profiles are in progress.

Web Site: Visit us at www.oit.doe.gov.



Benefits

BENEFITS OF PARTNERSHIP

Participation in the Industries of the Future strategy offers significant benefits to all partners. Manufacturers, suppliers, vendors, universities, industry associations, and others can

- reduce the cost and risk of non-proprietary R&D
- acquire a bigger voice in directing R&D
- stay at the forefront of technology and expand their knowledge base
- leverage available funds and information resources
- protect proprietary technologies and capabilities
- gain access to complementary technical expertise and facilities that can help today, as well as in the future
- gain new patents or licensing agreements
- potentially launch new products or spin-off companies.

Partnering generally enables a company to get more technology out of its available resources. Partners can bring to the table whatever they have to offer, whether it's funding, expertise, materials, facilities, specialized equipment, or another commodity. By combining resources, partners are able to tackle projects that would otherwise be too large, complex, costly, or time-consuming to undertake on their own. At the same time, the coordination of R&D that accompanies the partnering process dramatically decreases the redundancy of pre-competitive research efforts throughout industry.

The process pulls together the best available resources from a wide range of manufacturers, suppliers, customers, universities, research laboratories, industry associations, government agencies, and other organizations. As a result, the leading minds, latest technologies, and best analytical practices can be brought to bear on some of the most difficult technological hurdles to greater energy efficiency. Combining these talents and sharing experiences accelerates the attainment of R&D objectives and compresses product development cycles.

Moreover, by bringing suppliers, manufacturers, and customers together in the R&D, resulting products have a built-in market. Individual firms not only save money and boost their efficiency, but secure a place on the leading edge of their industry.

Each of the IOF industries has built up a diverse portfolio of research and development projects. The OIT Aluminum Team, for example, is providing cost-shared support to projects within each of the priority areas defined by the *Aluminum Industry Technology Roadmap*. The projects currently included in the Aluminum Industry of the Future portfolio are expected to reduce the amount of electricity required for producing primary aluminum by 25% to 30% and lower emissions of CO_2 and perfluorocarbons by 7.7 million tons (measured in carbon equivalent). In addition, the projects should lead to lighter, more fuel-efficient vehicles that will reduce carbon emissions by a further 1.6 million tons (in carbon equivalents) and will help to avoid sending 800,000 tons of aluminum salt cake to landfills.